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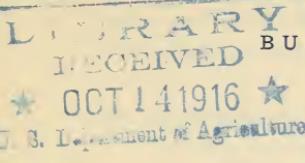
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B United States Department of Agriculture,



BUREAU OF PLANT INDUSTRY,

Western Irrigation Agriculture,

WASHINGTON, D. C.

THE WORK OF THE BELLE FOURCHE RECLAMATION PROJECT EXPERIMENT FARM IN 1915.

By BEYER AUNE, *Farm Superintendent.*

INTRODUCTION.

The Belle Fourche Experiment Farm consists of 280 acres of land on the Belle Fourche Reclamation Project in South Dakota, set aside by the Department of the Interior for experimental use. There are 240 acres under cultivation, 90 acres dry land and 150 acres irrigated. The farm has been in operation since 1907, but no water for irrigation was available until 1912. The work of the farm includes experiments in crop rotation and tillage, tests of grains and forage crops, and tests of trees for both windbreaks and ornamental plantings. The arrangement of the fields and the location of the experiments in 1915 are shown in figure 1.

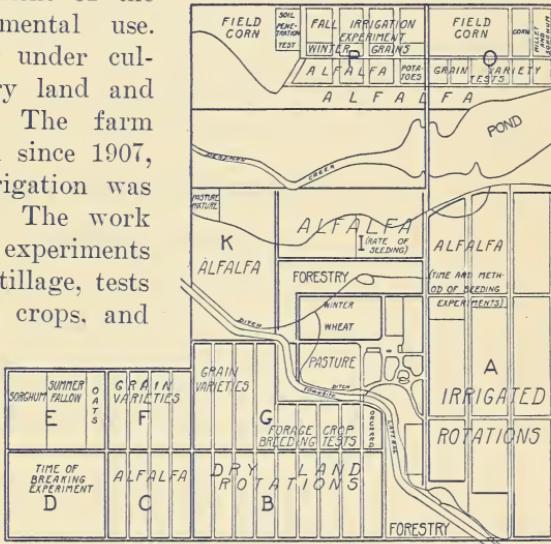


FIG. 1.—Diagram showing the arrangement of the fields and the location of the experiments at the Belle Fourche Experiment Farm in 1915.

COOPERATION.

The farm is in charge of the Office of Western Irrigation Agriculture of the United States Department of Agriculture, with the following offices cooperating:

Dry-land agriculture.—The Office of Dry-Land Agriculture uses about 20 acres of land above the canal for rotation and tillage ex-

periments. These experiments include continuous cropping by ordinary methods and moisture-conservation methods compared with alternate cropping and summer fallowing and a comparison of various crop rotations for the conservation of humus.

Cereal investigations.—The Office of Cereal Investigations has charge of the variety testing and plant breeding of small grains.

Alkali and drought resistant plant investigations.—The Office of Alkali and Drought Resistant Plant Investigations does the variety testing and plant-breeding work with forage crops and conducts studies of the water requirements of the different varieties and strains tested.

The above-mentioned offices have assistants detailed to the farm to supervise the work.

Biophysical Laboratory.—The Biophysical Laboratory cooperates in all climatological and physical observations. This work includes the measurements of rainfall, wind velocity, evaporation, temperature, and soil moisture.

Forest Service.—The United States Forest Service cooperates in the testing of trees for wood-lot and windbreak purposes. About 9 acres of land are used for this work.

Corn investigations.—The Office of Corn Investigations cooperates in the variety testing of corn. About 1 acre is used for this work.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

The precipitation in 1915 was 21.02 inches, which is 8.02 inches above the average for the previous seven years of record. The ground had a good covering of snow from December to March. Most of the rain came during the growing season, up to July 15. After this period conditions were very favorable for the harvesting of all crops. Other features of the weather were somewhat abnormal, as can be seen by referring to the tabular summary of the climatological observations. The number of clear days was below the normal. The last spring frost was on May 21 and the first fall frost on September 14, making a frost-free period of 116 days, which is 18 days less than the average for the last eight years. Very little irrigation was necessary except for second and third cuttings of alfalfa and late-maturing crops. Table I presents a summary of the climatological observations made at the experiment farm from 1908 to 1915, inclusive.

TABLE I.—Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1915, inclusive.

PRECIPITATION (INCHES).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908.....	0.20	0.19	1.65	1.16	3.95	1.47	1.26	0.62	0.52	2.03	0.20	0.91	14.16
1909.....	.17	.23	.19	.84	3.87	5.59	2.45	.55	1.07	.76	.73	1.28	17.73
1910.....	.73	.70	.93	1.57	1.26	1.51	1.42	1.03	2.92	.27	.11	.10	12.25
1911.....	.13	.05	.09	.17	.45	.50	.80	1.86	.92	.39	.98	.30	6.64
1912.....	.24	.10	.71	2.32	2.26	.29	3.20	2.80	3.49	.51	.04	.13	16.09
1913.....	.57	.24	.99	.25	1.98	3.10	.35	.26	2.38	1.86	.10	.45	12.53
1914.....	Trace	1.00	.29	1.09	2.22	2.09	1.34	1.12	.35	1.77	0	.43	11.70
1915.....	.92	1.01	.16	2.58	2.32	4.74	5.74	.44	1.26	1.25	.43	.17	21.02
Average....	.37	.44	.63	1.25	2.29	2.41	2.07	1.09	1.61	1.11	.32	.47	14.02

EVAPORATION (INCHES).

1908.....	5.53	5.92	6.82	8.08	7.87	6.75	.....	.....	.....	.....	.....	.....	40.97
1909.....	3.65	6.42	5.86	7.70	8.25	5.00	.....	.....	.....	.....	.....	.....	36.88
1910.....	5.41	5.31	8.98	10.42	7.30	4.31	.....	.....	.....	.....	.....	.....	41.73
1911.....	4.65	8.30	10.24	10.71	6.68	6.11	.....	.....	.....	.....	.....	.....	46.69
1912.....	4.85	6.42	8.18	7.92	6.60	3.71	.....	.....	.....	.....	.....	.....	37.74
1913.....	4.71	4.30	7.05	8.24	8.14	4.71	.....	.....	.....	.....	.....	.....	37.15
1914.....	3.37	5.13	6.71	8.74	6.97	4.19	.....	.....	.....	.....	.....	.....	35.11
1915.....	4.45	2.97	4.61	5.35	5.11	3.95	.....	.....	.....	.....	.....	.....	26.44
Average....	4.58	5.60	7.31	8.40	7.12	4.84	.....	.....	.....	.....	.....	.....	37.84

WIND VELOCITY (MILES PER HOUR).

Mean:														
1908.....				8.3	7.2	5.0	6.8	6.5	.....	.....	.....	.....	.....
1909.....				9.1	10.1	6.2	6.0	5.6	5.7	6.3	5.5	.....	.....
1910.....				6.3	9.2	8.2	9.3	7.7	6.6	6.2	7.1	6.5	9.2	
1911.....				7.5	5.8	9.6	9.2	11.6	9.1	7.9	7.3	.....	.....
1912.....				6.9	7.3	6.6	9.5	11.1	7.6	6.0	6.9	7.6	.....
1913.....						6.2	5.9	6.8	5.8	5.1	4.5	.....	.....
1914.....						8.2	7.7	6.7	5.0	5.0	6.2	.....	.....
1915.....						7.4	6.2	5.0	4.1	5.9	.....	.....	.....
Maximum:														
1908.....						19.6	12.1	12.9	9.0	13.8	.....	.....	.....
1909.....						26.8	21.7	12.9	11.6	11.8	9.8	13.8	15.0	
1910.....						18.9	23.8	22.0	19.4	17.6	17.6	12.1	18.3	16.7
1911.....				18.8	11.4	19.6	18.6	19.4	20.7	19.4	15.2	15.9	.....	28.0
1912.....				17.5	16.7	18.8	24.9	25.3	17.5	10.0	12.4	26.3	.....	21.7
1913.....						16.5	12.4	18.9	14.4	9.0	9.0	13.8	.....	.....
1914.....						15.6	23.0	15.1	9.9	13.1	14.5	.....	.....	.....
1915.....						15.4	13.0	10.8	9.4	15.6	.....	.....	.....	.....
Minimum:														
1908.....						2.1	1.7	2.5	2.9	.....	.....	.....	.....	.....
1909.....						2.5	2.6	2.9	2.5	2.5	2.5	2.1	.9	.....
1910.....						1.7	3.1	1.6	3.1	3.0	2.9	2.2	2.5	1.8
1911.....				1.2	.8	2.4	3.3	3.9	4.5	2.8	2.6	2.5	1.3	2.1
1912.....				.8	2.1	1.8	3.0	2.9	2.8	3.0	2.1	1.5	.....	.....
1913.....						1.3	1.2	2.4	1.7	1.9	.9	.....	.....	.....
1914.....						4.0	2.0	2.9	1.6	2.1	2.2	.....	.....	.....
1915.....						2.0	2.0	1.5	1.8	1.5	.....	.....	.....	.....

TABLE I.—*Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1915, inclusive—Continued.*

MONTHLY TEMPERATURE (° F.).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Mean:													
1908.....				48	52	63	73	68	64	45	37	22	
1909.....	12	23	32	38	52	66	70	75	61	46	21	10	
1910.....	18	8	46	51	52	68	76	68	59	51	31	25	
1911.....	20	22	39	42	58	73	71	65	59	43	25	20	
1912.....	12	25	19	47	55	66	70	68	52	45	38	28	
1913.....	13	17	23	48	53	66	70	74	59	42	37	23	
1914.....	27	14	33	43	55	65	76	69	62	49	39	15	
1915.....	16	19	21	52	51	58	64	66	56	50	34	25	
Maximum:													
1908.....				89	79	90	100	101	105	82	75	49	
1909.....	50	51	65	73	84	95	100	105	96	84	73	49	
1910.....	45	46	87	89	81	108	109	101	97	91	67	52	
1911.....	59	61	78	88	90	101	105	100	94	82	58	51	
1912.....	44	49	70	78	84	101	94	95	94	85	70	57	
1913.....	48	62	54	89	95	98	101	104	97	80	64	51	
1914.....	61	60	70	78	85	98	104	102	101	88	71	48	
1915.....	53	40	50	83	84	84	88	97	100	81	68	57	
Minimum:													
1908.....				5	29	39	43	39	22	22	....	-12	
1909.....	-24	-19	12	6	22	45	41	45	31	11	-7	-23	
1910.....	-19	-26	22	24	27	36	44	32	30	13	8	-13	
1911.....	-22	-7	8	7	23	43	41	32	35	-1	-8	-25	
1912.....	-32	-12	-15	22	32	39	40	47	24	22	11	2	
1913.....	-32	-14	-20	24	26	45	42	45	29	14	14	-1	
1914.....	-1	-28	4	8	30	44	48	40	35	25	9	-21	
1915.....	-26	-11	-9	26	28	33	41	40	30	21	7	-13	

KILLING FROSTS.

Season.	1908	1909	1910	1911	1912	1913	1914	1915	Eight-year average.
Last in spring.....	May 21	May 18	May 21	May 12	May 4	May 6	May 12	May 21	.....
First in fall.....	Sept. 22	Sept. 24	Sept. 26	Oct. 4	Sept. 25	Sept. 24	Oct. 4	Sept. 14	.....
Frost-free period (days) ..	128	128	127	146	144	141	145	116	134

AGRICULTURAL CONDITIONS.

The area of land cropped on the Belle Fourche project in 1915 was larger by 6,157 acres than in 1914, an increase of about 16.5 per cent. The total irrigable area of the 717 farms on the project in 1915 was 55,298 acres. The total area actually irrigated was 44,067 acres, and the total area from which crops were harvested was 42,866 acres. During the year 2,365 acres were planted to alfalfa, of which 1,472 acres were planted with a nurse crop and 893 acres without a nurse crop. The acreage in alfalfa in 1915 was 16,152, an increase of 6,407 acres over 1914. About 15 per cent of the total irrigable area was in wheat in 1915. The wheat crop was second in importance as to both acreage and money value. This relatively large area devoted to wheat is rather unusual on irrigation projects. It is due mostly to the fact that for the first year or two on the new lands of the project wheat is the easiest crop to grow and usually finds a

ready market. There were reported 3,273 acres in pasture, a little less than in 1914. The acreage devoted to pasture is either native grasses or alfalfa pastured with hogs. No regular pasture grasses for cattle or sheep have yet come into general use on the project. In previous years alfalfa seed has been a profitable crop, but in 1915 practically no seed was produced, owing to unfavorable climatic conditions.

During the season two hailstorms occurred, but their effects were local. In July a strip from 3 to 5 miles wide, containing about 5,500 acres and crossing the project from north to south, was hailed out. A second storm occurred on October 2, crossing the project from east to west and covering a strip about 4 miles wide. This storm was so late that very little damage was done. There was no serious damage from insect pests, and there were very few plant diseases, although late-seeded grains were badly affected with rust.

The acreage, yields, and farm values of the crops produced on the project in 1915 are stated in Table II, the figures being obtained from the United States Reclamation Service.

TABLE II.—*Acreage, yields, and farm values of the crops produced on the Belle Fourche Reclamation Project in 1915.*

Crop.	Area (acres).	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Per acre.
				Average.	Maximum.			
Alfalfa hay.....	16,152	Ton.....	34,842	2.2	5.0	\$4.50	\$156,789	\$9.90
Alfalfa seed.....	284	Bushel.....	65	.2	3.0	10.00	650	2.00
Barley.....	1,613	do.....	47,365	29.3	69.6	.65	30,757	19.05
Beans.....	36	do.....	132	5.1	24.0	3.00	396	15.30
Beets, sugar.....	31	Ton.....	311	10.0	22.0	4.00	1,244	40.00
Clover hay.....	92	do.....	170	1.8	3.0	4.00	680	7.20
Corn.....	4,470	Bushel.....	64,098	14.3	35.0	.50	32,049	7.15
Corn fodder.....	1,866	Ton.....	1,208	.6	3.0	5.00	6,040	3.00
Flax.....	48	Bushel.....	408	9.0	13.0	1.80	735	16.20
Garden.....	133	do.....	.....	.....	.....	.....	7,690	58.20
Hay.....	2,782	Ton.....	2,507	.9	2.0	10.00	25,070	9.00
Millet seed.....	46	Bushel.....	529	11.5	30.4	1.00	529	11.50
Oats.....	4,440	do.....	165,260	37.3	109.0	.40	66,104	14.92
Onions.....	14	do.....	1,350	96.0	700.0	.80	1,080	76.80
Pasture.....	3,273	do.....	.....	.....	.....	.....	14,105	4.32
Potatoes.....	161	Bushel.....	17,984	111.5	300.0	.50	8,992	55.75
Rye.....	135	do.....	2,184	16.2	25.0	.90	1,966	14.58
Wheat.....	7,747	do.....	133,248	17.2	41.0	.80	106,598	13.76
Miscellaneous.....	89	do.....	.....	.....	.....	.....	546	6.13
Less duplicated areas.....	349	do.....	.....	.....	.....	.....	.....	.....
Total.....	42,866	.....	.....	.....	.....	.....	462,050	10.80
Average.....	.....	.....	.....	.....	.....	.....	.....	.....

Table III shows the live stock on hand on January 1 and on December 31, 1915, their value, and also the increase in total values. These figures were obtained from the United States Reclamation Service.

TABLE III.—*Inventory of live stock on the Belle Fourche Reclamation Project in 1915.*

Item.	Inventory, January 1.			Inventory, December 31.			Increased or decreased total value.
	Number.	Value.	Total value.	Number.	Value.	Total value.	
Horses.....	2,848	\$87.50	\$249,150	3,135	\$92.80	\$290,875	\$41,725
Mules.....	59	112.10	6,635	65	120.00	7,805	1,170
Cattle:							
Beef.....	2,514	46.50	116,901	5,524	47.60	262,480	145,579
Dairy.....	1,578	57.75	91,129	2,200	56.10	123,195	32,066
Sheep.....	25,740	3.76	96,782	26,210	4.48	117,296	20,514
Hogs.....	11,988	8.97	107,772	14,798	6.75	99,640	-8,132
Fowls.....	29,186	.49	14,252	21,315	.48	12,533	-1,719
Bees, hives.....	129	6.20	801	326	7.45	2,429	1,628
Total.....			683,422			916,253	232,831

Table III shows a marked increase in the number of beef cattle. This increase was due chiefly to the extensive receipts of beef cattle, for both feeding and breeding purposes. On January 1 there were 2,514 beef cattle, and on December 31, 5,524, an increase of 3,010 head, or 116 per cent. The number of dairy cattle on January 1 was 1,578, and on December 31, 2,200, an increase of 622 head, or 38 per cent. The sheep on the project are mostly feeders and show only a slight increase over 1914. The number of hogs increased nearly 3,000.

Table IV shows the number of carloads of cattle, sheep, hogs, and horses shipped from the project towns during the year 1915, and of cattle and sheep shipped in during the same period, according to the figures obtained from the district freight office at Deadwood, S. Dak.

TABLE IV.—*Carload shipments and receipts of live stock at four shipping points on the Belle Fourche Reclamation Project in 1915.*

Shipping point.	Forwarded.				Received.	
	Cattle.	Sheep.	Hogs.	Horses.	Cattle.	Sheep.
Bellefourche.....	238	27	285	60	217	9
Fruitdale.....	17	34	7	.....	7	1
Nisland.....	9	64	29	10	10	8
Newell.....	50	74	141	14	46	10
Total.....	314	199	462	84	280	28

The rapid growth of live-stock industries on the project is one of the most encouraging features of the year's development. It seems certain that these industries will occupy an increasingly important position in the agriculture of the project.

ROTATION EXPERIMENTS WITH IRRIGATED FIELD CROPS.

In 1912 a series of crop-rotation experiments under irrigation was started. The series included 20 plats of alfalfa, 15 of sugar beets, 13 of potatoes, 18 of oats, 2 of winter wheat, 5 of spring wheat, 1 of barley, 3 of flax, and 1 of clover, a total of 76 quarter-acre plats. In

the original series there are twelve 2-year rotations, three 3-year rotations, four 4-year rotations, and five 6-year rotations; and, in addition, nine plats are used for continuous cropping to each of the crops used in the rotations. In 1914 duplicates of the continuously cropped plats were added to the series. In 1914 another 6-year rotation, No. 69, was added. This new rotation includes two years of corn, one of oats, and three of alfalfa. The third-year alfalfa is to be pastured by hogs and the two plats of corn are to be hogged off. There are at present 101 quarter-acre plats in the rotation experiments. Table V gives the average, maximum, and minimum yields per acre from these plats in 1915 and a comparison of the average yields in 1912, 1913, and 1914.

TABLE V.—*Yields of the crops grown in the irrigated rotation experiments at the Belle Fourche Experiment Farm, 1912 to 1915, inclusive.*

Number of plats.	Crop.	Yields per acre, 1915.			Comparison of average yields per acre.		
		Maxi- mum.	Min- imum	Average.	1912	1913	1914
23	Alfalfa.....tons..	4.8	1.01	3.17	.....	2.6	3.0
16	Sugar beets.....do..	16.0	4.6	9.2	7.6	7.8	11.6
6	Corn.....bushels..	32.2	12.8	27.6	28.7	34.0	43.6
7	Spring wheat.....do..	30.4	12.1	20.9	22.1	19.9	25.7
3	Winter wheat.....do..	44.3	15.8	27.1	.....	11.3	22.9
20	Oats.....do..	118.5	39.9	92.1	51.9	39.0	78.8
2	Barley.....do..	63.3	39.0	51.2	28.0	14.8	31.7
4	Flax.....do..	18.7	8.3	15.1	13.6	13.4	14.8
14	Potatoes.....do..	192.0	58.7	116.8	45.5	112.5	105.9
2	Clover.....tons..	1.56	.8	1.18	.....	.....	.44
2	Clover seed.....bushels..	2.7	.83	1.77	.....	.....	.....

Table V shows a wide difference in yields obtained from the different plats. In most cases the highest yield is more than three times as much as the lowest. With the exception of alfalfa, each crop was planted in the various plats at the same time with the same variety of seed and given similar cultural treatment, so the differences in yield result from differences in soil and crop sequence and the application of manure. It seems that during the early years of the experiment soil variation has been an important factor, but its relative importance appears to be reduced as time goes on. It is generally believed that a rotation of crops and the use of farm manure are beneficial, but there is very little quantitative knowledge on these points with respect to these new irrigated lands.

With the season of 1915 the experiment completes its fourth year, but it is still too soon to draw any definite conclusions, as the soil variation still is an important factor and some of the rotations have not yet completed their first cycle. From the results obtained in 1915 some notes may be useful to those engaged in crop production under conditions similar to those where this experiment is being conducted.

The average yield of alfalfa shown in Table V includes the yields of all alfalfa plats in the rotations. The maximum yield of the established alfalfa was 4.37, the minimum 3.26, and the average 3.97 tons per acre. The maximum yield of first-year alfalfa sown in the fall of 1914 was 4.8 tons per acre, the minimum 3, and the average 3.63 tons per acre. The maximum yield of first-year alfalfa planted in the spring of 1915 was 1.17, the minimum 1.01, and the average 1.09 tons per acre. The second cutting of spring-seeded alfalfa was so damaged by hail that no yields were obtained.

The maximum yield of sugar beets was 16 tons per acre, the minimum 4.6 tons, and the average 9.43 tons per acre. The highest



FIG. 2.—Sugar beets in rotation No. 21, in which beets followed potatoes, at the Belle Fourche Experiment Farm. This plat yielded at the rate of 16 tons per acre in 1915.

yield was obtained in a 2-year rotation of potatoes and beets, manured. A view of this beet plat is shown in figure 2. The lowest yield was in the continuously cropped plat. The average yield was 1.73 tons per acre lower than in 1914. In three rotations where barnyard manure was applied at the uniform rate of 12 tons per acre, the average yield was 13.3 tons per acre. In three comparable rotations without manure the average yield was 8.7 tons per acre, showing a difference of 4.6 tons per acre in favor of the manured plats. Sugar beets following a grain crop have given uniformly poor results every year. The average sugar content of the beets grown in the rotation experiments for the four years, 1912, 1913, 1914, and 1915, was 14.8, 19.1, 22.1, and 17.7 per cent, respectively.

The yields of oats, potatoes, and beets in 1915 and the preceding crop in each case are shown in Table VI. The yields of each crop

are arranged in order, from the highest to the lowest, showing which preceding treatment gave the best results in 1915. It must be kept in mind that all the plats are not on equally good soil and that the difference in yield is due to soil variation as well as to crop sequence.

TABLE VI.—Yields per acre of oats, potatoes, and beets, with statement of the preceding crops in the irrigated rotations at the Belle Fourche Experiment Farm, 1915.

(MB indicates manure applied to the beet crop; OR indicates oats followed by rye, to be plowed under the following spring; OM indicates oats with manure applied to the stubble and plowed under for the following crop.)

Oats.			Potatoes.			Beets.		
Preceding crops.	Rotation No.	Yield.	Preceding crops.	Rotation No.	Yield.	Preceding crops.	Rotation No.	Yield.
*			Bushels.			Bushels.		Tons.
Alfalfa.....			MB.....			Potatoes.....		
Do.....	48	118.5	Potatoes.....	21	192.0	MB.....	21	16.0
Wheat.....			MB.....			Potatoes.....		
Alfalfa.....			OM.....			Beets.....		
Corn.....	65	117.1	Potatoes.....	25	168.0	Potatoes.....	31	13.2
Flax.....			OM.....			OM.....		
Alfalfa.....			Oats.....			Potatoes.....		
Do.....	44	116.5	Alfalfa.....	44	144.0	Beets.....	20	12.2
Potatoes.....			Do.....			Potatoes.....		
Alfalfa.....			Potatoes.....	4a	142.3	OM.....		
Do.....	61	114.1	Do.....			Beets.....	23	11.8
Potatoes.....			Do.....			OM.....		
Do.....			OM.....	31	137.0	Alfalfa.....		
Oats.....	24	112.0	Beets.....			Do.....	40	11.0
Potatoes.....			Alfalfa.....			Potatoes.....		
Alfalfa.....			Do.....	61	115.3	Alfalfa.....		
Do.....	60	108.9	Do.....			Potatoes.....	60	9.4
Potatoes.....			Corn.....			Oats.....		
Oats.....			Potatoes.....	26	112.0	Alfalfa.....		
Beets.....	30	106.9	Corn.....			Potatoes.....	60	9.4
Potatoes.....			Oats.....			Oats.....		
Beets.....			Potatoes.....	24	111.3	Do.....		
OM.....	23	104.5	Oats.....			Beets.....	22	9.1
Beets.....			Alfalfa.....			Oats.....		
Potatoes.....			Do.....	60	105.3	Wheat.....		
OM.....	25	104.0	Do.....			Beets.....	18	8.8
Potatoes.....			Beets.....			Wheat.....		
OM.....			Potatoes.....	20	102.0	Alfalfa.....		
Beets.....	31	104.0	Beets.....			Corn.....	62	8.3
Potatoes.....			Do.....			Oats.....		
Do.....			Alfalfa.....	40	94.0	Beets.....		
OR.....	27	101.3	Do.....			Potatoes.....	30	7.3
Potatoes.....			Potatoes.....			Oats.....		
Beets.....			Do.....	4	86.0	Alfalfa.....		
Oats.....	22	99.1	Do.....			Do.....	42	7.0
Beets.....			OR.....			Oats.....		
Oats.....			Potatoes.....	27	66.7	Beets.....		
Do.....	1a	82.5	OR.....			Corn.....	32	6.8
Alfalfa.....			Potatoes.....			Oats.....		
Do.....	62	79.8	Oats.....	30	58.7	Beets.....		
Corn.....			Beets.....			Do.....	2a	6.2
Beets.....						Corn.....		
Alfalfa.....						Wheat.....	66	5.1
Do.....	42	74.6				Clover.....		
Oats.....						Beets.....		
Beets.....						Do.....	2	4.6
Corn.....	32	72.5				Do.....		
Corn.....								
Oats.....	16	65.3						
Corn.....								
Wheat.....								
Oats.....	28	50.0						
Wheat.....								
Oats.....								
Do.....	1	39.9						
Do.....								
Average of all plats.		92.1				116.7		9.2

In three rotations where manure was applied at the rate of 12 tons per acre, the average yield of potatoes was 165.6 bushels per acre. In three comparable rotations without manure the average yield was 89.8 bushels per acre, showing an increase of 75.8 bushels per acre in favor of the manure. Potatoes so far have not in themselves been a profitable crop on this heavy gumbo soil. They have, however, shown such a beneficial effect on the crops that follow them, especially sugar beets and grains, that they might be grown to some extent for this reason.

The maximum yield of oats was 118.5, the minimum 39.9, and the average 92.1 bushels per acre. The maximum yield was obtained



FIG. 3.—Oats in rotation No. 65, which yielded at the rate of 117.1 bushels per acre, at the Belle Fourche Experiment Farm in 1915.

in a 4-year rotation of alfalfa, alfalfa, wheat, and oats, but this was probably due largely to soil variation, as this rotation has given the highest yield every year since the rotations were commenced. The residual effect after pasturing alfalfa and corn in rotation No. 65 was very marked in 1915. At the beginning of the experiment in 1912 this rotation gave only an average yield, but it has improved each year, so that in 1915 the yield of oats in this rotation was 117.1 bushels per acre, which was next to the highest yield obtained. A view of the oat plat in 1915 is shown in figure 3. So far, rotations with manure have given no increased yields of oats. Oats after beets have given very good results, while after corn the yields have not been so satisfactory.

The corn yield in 1915 was very unsatisfactory and the lowest of any since the experiment was commenced, as the corn did not ripen properly.

The maximum yield of wheat was 30.4, the minimum 12.1, and the average 20.9 bushels per acre. The highest yield was obtained in rotation No. 48, where wheat follows alfalfa, and the lowest in a 2-year rotation of oats and wheat. Wheat after beets has given good results every year. The low average yield of wheat in 1915 was due largely to late seeding, as all late-seeded grains were badly affected with rust.

The maximum yield of flax was 18.7, the minimum 8.3, and the average 15.1 bushels per acre. Flax has given good results every year after both corn and beets. The highest yield in 1915 was obtained after corn (hogged) in rotation No. 65. The lowest yield was obtained from the continuously cropped plat, but this is not due altogether to crop sequence, as the yields of this plat have been uniformly low every year.

Barley in 1915 showed a more marked improvement than any other crop. This might have been due to the favorable season for this grain and also to the variety used. In previous years, Minnesota No. 6, a 6-rowed barley, has been used. In 1915, Chevalier, a 2-rowed variety, was used. The highest yield was 63.3, the lowest 39, and the average 51.2 bushels per acre.

From the four years' observations, the more important indications have been as follows: Alfalfa has shown no marked increase in the yield of crops that follow it. Grains following cultivated crops have given better net returns per acre than when following alfalfa or grain. The application of manure has shown a marked increase in the yield of beets and potatoes, but not of grains. Beets following a grain crop have given uniformly poor results every year. Alfalfa seeded shortly after the grain is removed in the late summer has produced the most satisfactory stands. Early-seeded spring grains have given much better results, as to both quality and yield, than late-seeded spring grains.

PASTURING ALFALFA WITH HOGS.

In the 6-year rotation (No. 65), including three years of alfalfa, corn, flax, and oats, the third-year alfalfa is pastured by hogs until the corn is ripe, and then the hogs are turned into the corn. In 1915 another 6-year rotation was added, consisting of three years of alfalfa, two years of corn, and one of oats. The third-year alfalfa is to be pastured each year, and the corn is to be hogged. The hogs while on alfalfa pasture are fed a daily ration of 2 pounds of corn for each 100 pounds of live weight.

On May 5, 1915, four fall pigs, averaging 124 pounds each, were put on the alfalfa plat in rotation No. 65. On June 3 one of these was taken off and the remainder pastured until July 5, when they were taken off. Another lot of 10 spring pigs, averaging 36 pounds in weight, were put on the plat July 7. As the plat was pastured too closely, three of these pigs were taken out on August 7, and three more on September 6. The average live weight for the season was 2,002.8 pounds per acre. The total gain made by the hogs for the period of 131 days was 506 pounds for the quarter-acre plat, or 2,024 pounds per acre. During the pasturing season the hogs on the quarter-acre plat were fed 1,196 pounds of corn, or 4,787 pounds per acre, worth locally \$1.70 per hundred. At the time when the experiment was completed hogs sold at Newell for 7 cents per pound. It took 2.36 pounds of corn to make 1 pound of gain when the hogs were pastured on alfalfa. The net return per acre, exclusive of labor, was \$60.32 in rotation No. 65. The hogs in rotation No. 69 were handled in a similar manner, the return being \$62.97 per acre. The results of pasturing alfalfa in rotation No. 65 for three years and in rotation No. 69 for one year are shown in Table VII.

TABLE VII.—*Results of pasturing alfalfa with hogs at the Belle Fourche Experiment Farm in 1913, 1914, and 1915.*

Year.	Rotation No.	Time on pasture.	Average live weight per acre.	Grain fed per acre.	Gains made per acre.	Grain per pound of gain.	Net returns per acre of alfalfa.
1913.....	65	Days. 94	Pounds. 1,808	Pounds. <i>a</i> 4,292	Pounds. 1,068	Pounds. 4.01	\$21.14
1914.....	65	121	1,815	<i>b</i> 5,104	1,830	2.79	41.44
1915.....	65	132	2,002.8	<i>b</i> 4,787	2,024	2.36	60.32
1915.....	69	132	2,060.5	<i>b</i> 4,976	2,108	2.36	62.97

a Equal parts of ground oats, wheat, and barley.

b Corn.

In computing these net returns a charge of \$1.70 per 100 pounds is made for the corn, and a value of 7 cents a pound (live weight) is assigned to the pork produced.

When pasturing hogs on alfalfa, much better returns are obtained if the pasture is divided into two lots and the hogs changed from one to the other about every ten days or two weeks. Frequent irrigation is necessary, especially in dry weather. The hogs should not be allowed on the pasture while the soil is wet.

Shorts as a supplement for alfalfa pasture.—In order to compare shorts with corn as a supplemental feed for hogs on alfalfa pasture, two quarter-acre plats of third-crop alfalfa were fenced and hogs turned in on August 11, 1915. One lot was fed a 2 per cent ration of corn and the other lot a 2 per cent ration of shorts. There were in each lot seven spring pigs, averaging 48 pounds each. Both lots

were on pasture for 36 days. During this time a total gain of 141 pounds was made by the corn-fed lot, which received 281.2 pounds of corn. Thus it required 1.98 pounds of corn for each pound of gain. Figuring corn at \$1.70 per hundred and pork at 7 cents a pound, the net return for the quarter acre of alfalfa was \$5.09, or at the rate of \$20.36 per acre for 36 days. During this period a total gain of 136 pounds was made by the lot fed shorts. This lot received 275.4 pounds of shorts. Thus it required 2.02 pounds of shorts for each pound of gain. Figuring shorts at \$1.70 per hundred and pork at 7 cents a pound, the net return for the quarter-acre plat was \$4.84, or at the rate of \$19.36 per acre, for 36 days.

From these results it appears that a pound of shorts is practically as good as a pound of corn as a supplemental feed for hogs on alfalfa pasture. Which of these feeds to use will depend largely on the market prices of corn and shorts.

HOGGING CORN.

The five hogs remaining on the alfalfa plat in rotation No. 65 were turned on the corn plat on September 27 and left until the grain had been consumed. The hogs were on the corn for 15 days. During this time they gained 137 pounds on the quarter-acre plat, or at the rate of 548 pounds per acre. Pork in Newell at the completion of this experiment was worth 7 cents per pound. At this rate the return per acre was \$38.86. The estimated yield of corn on this plat was 40.6 bushels per acre. On the basis of this estimate, the hogs paid 95 cents a bushel for the corn consumed. Figured in the same way the return on rotation No. 69, where the estimated yield of corn was 34 bushels per acre, was \$31.57 per acre, and the price paid for the corn was 93 cents per bushel.

Table VIII shows the results of hogging corn for the four years that the experiments have been running.

TABLE VIII.—*Results of hogging corn at the Belle Fourche Experiment Farm, 1912 to 1915, inclusive.*

Year.	Ro-tation No.	Num-ber of days.	Live weight per acre when turned on corn.	Gains per acre.	Estimated yield of corn per acre.	Estimated price paid for corn per bushel.	Price received for pork per pound.	Return per acre of corn.
			Pounds.	Pounds.	Bushels.			
1912.....	65	26	680	340	28.7	\$0.94	\$0.08	\$27.20
1913.....	65	11	1,632	560	34.0	1.13	.07	39.20
1914.....	65	20	1,708	582	34.8	1.17	.07	40.72
1915.....	65	15	1,620	548	40.6	.95	.07	38.86
1915.....	69	10	1,780	451	34.0	.93	.07	31.57

The results obtained since the experiment was commenced in 1912 show that pasturing alfalfa and hogging corn are profitable methods of marketing these two crops. The saving of labor and the improvement in the soil are important points in favor of the practice.

PASTURING SHEEP ON ALFALFA.

There is widespread prejudice against pasturing sheep on alfalfa because of the danger of loss from bloat, but several local stockmen use alfalfa for sheep, particularly in late summer and the fall. It is believed by these stockmen that if sheep are not hungry and are



FIG. 4.—Lambs pasturing on third-crop alfalfa at the Belle Fourche Experiment Farm in 1915. These 10 lambs gained 155 pounds on an acre of alfalfa in 40 days.

turned on the alfalfa for the first time in the evening and kept there continuously, few or no losses will occur.

On August 28, 10 lambs, with an average weight of 75 pounds each, were turned into a 1-acre field of third-crop alfalfa. They were pastured there for 40 days. A view of the pasture is shown in figure 4. The pasture was divided into two lots, which were pastured alternately. During this time the lambs made a total gain of 155 pounds, or an average gain of 0.39 of a pound each per day. Individual weights were taken every 10 days during the period. With the gains worth 7 cents a pound, a return of \$10.85 was secured for 40 days' use of 1 acre of alfalfa pasture. No bloating occurred.

PASTURE-GRASS MIXTURES.

In order to determine the feasibility of pasturing on the irrigated lands of the project, a test of pasture-grass mixtures was started in 1913. The following mixtures were seeded at the rate in pounds per acre specified below:

Mixture A contains timothy, 4 pounds; reedtop, 4 pounds; Kentucky blue-grass, 4 pounds; Italian rye-grass, 2 pounds; orchard grass, 6 pounds; brome-grass, 2 pounds; meadow fescue, 2 pounds; tall fescue, 2 pounds; western wheat-grass, 2 pounds; perennial rye-grass, 2 pounds; and tall oat-grass, 2 pounds.

Mixture B is the same as mixture A except that 2 pounds per acre of white clover and 2 pounds per acre of alsike clover were added.

Mixture C is the same as mixture B except that 2 pounds of alfalfa seed per acre were added.

The mixtures were planted on May 24, 1913, on quarter-acre plats. The land was in very poor condition and difficult to irrigate, and the resulting stand was poor. Very little pasture was obtained during the summer of 1913. The growth of the grasses improved considerably, however, during the summer of 1914, and the following results were obtained in 1915:

Mixtures A and B each furnished 21 days' pasture for one cow. Mixture C was cut for hay on June 20 and yielded at the rate of $1\frac{1}{2}$ tons per acre. After that time it furnished 29 days' pasture for one cow.

No difficulty with bloat was encountered in pasturing on mixture C, containing the alfalfa. The pasturing was commenced on June 10 and continued for 85 days. During this time the cow was taken out for a total of 15 days, making the total pasturing 70 days on the three quarter-acre plats.

The cow was dry when first turned on the pasture, but she freshened on June 19. From that date to the close of the pasture period, September 3, she produced 2,682 pounds of milk and 98 $\frac{1}{2}$ pounds of butter fat.

In the spring of 1915 mixtures A, B, and C were planted on better land. An additional mixture of 20 pounds of brome-grass, 12 pounds of western wheat-grass, and 3 pounds of alfalfa was also planted. The grasses used in the different mixtures were planted separately in small plats to facilitate a better study of them. Before the grasses were seeded $1\frac{1}{2}$ bushels of oats per acre were drilled in as a nurse crop. The oats were not allowed to mature, but were clipped and left on the ground whenever their height reached about 6 inches. The nurse crop appeared to be a decided advantage on this heavy soil, as the ground could then be irrigated without washing or baking. Frequent irrigation is absolutely necessary for all these pasture mixtures, as most of the grasses are shallow rooted. During the summer they should be irrigated every week or 10 days. The pasture should

also be divided, so the stock can be changed from one to the other between irrigations.

EXPERIMENTS WITH ALFALFA.

Alfalfa is one of the most important crops on the Belle Fourche project and makes an excellent feed when properly handled. Alfalfa seed is usually a very profitable crop, but in 1915 practically no seed was produced in western South Dakota. In the eight years that the experiment farm has been in operation the alfalfa-seed crop has failed but twice. Some of the more important results secured in the experiments with alfalfa in 1915 are briefly discussed below.

TIME AND METHOD OF SEEDING.

The yields of hay in 1915 from three cuttings of alfalfa seeded at different times and by different methods in 1914 are shown in Table IX.

TABLE IX.—*Yields of alfalfa in 1915 in the time and method of seeding experiment started in 1914 at the Belle Fourche Experiment Farm.*

Time and method of seeding.	Yield of hay per acre (tons).			
	First cutting.	Second cutting.	Third cutting.	Total.
Planted without a nurse crop:				
Early, May 8.....	1.34	1.23	1.29	3.86
Late, June 11.....	1.32	1.38	1.32	4.02
In rows 21 inches apart.....	.92	1.15	1.03	3.10
With wheat as a nurse crop:				
Cut for hay.....	1.45	1.53	1.38	4.36
Cut for grain.....	1.13	1.27	1.23	3.63
With oats as a nurse crop, cut for grain.....	.65	.87	1.04	2.51
With barley as a nurse crop, cut for grain.....	.80	1.34	1.50	3.64
With flax as a nurse crop, cut for grain.....	1.20	1.32	1.20	3.75

In 1915 there was a slight difference in hay yields in favor of planting alfalfa without a nurse crop, but the returns in 1914 were in favor of using grain as a nurse crop because of the value of the grain secured. Very good results have been obtained with flax as a nurse crop where the nurse crop has been harvested for grain. Flax, wheat, barley, and oats as nurse crops for alfalfa rank in value in the order named.

RATE OF SEEDING.

In the spring of 1913 a rate-of-seeding test was started. Fourteen different rates were used, varying from $2\frac{1}{2}$ pounds to 25 pounds per acre on twentieth-acre plats. In the spring of 1914 this experiment was repeated. Table X gives the results secured in 1915 from these two plantings.

TABLE X.—*Yields of alfalfa in 1915 in rate-of-seeding tests at the Belle Fourche Experiment Farm.*

Test and plat.	Rate of seeding.	Height at maturity (inches).				Yield per acre (tons).			
		First crop.	Second crop.	Third crop.	Average.	First crop.	Second crop.	Third crop.	Total.
<i>Test started in 1913:</i>									
No. 1.....	<i>Pounds.</i> 2.5	22.5	24.0	25.0	23.8	1.40	1.10	1.24	3.74
No. 2.....	3.0	22.5	24.0	25.0	23.8	1.00	1.50	1.26	3.76
No. 3.....	4.5	22.0	22.5	24.0	22.8	1.10	1.45	.90	3.45
No. 4.....	6.0	22.0	20.0	24.0	22.0	.90	1.55	1.06	3.51
No. 5.....	8.0	21.0	19.0	23.0	21.0	1.20	1.30	1.06	3.56
No. 6.....	10.0	21.0	19.0	22.0	20.7	1.16	1.40	1.02	3.58
No. 7.....	11.5	20.0	18.0	22.0	20.0	.90	1.10	1.28	3.28
No. 8.....	13.0	20.5	18.0	22.0	20.2	1.10	1.20	1.02	3.32
No. 9.....	15.0	20.0	17.5	21.0	19.5	1.04	1.40	1.25	3.69
No. 10.....	16.5	18.0	17.0	21.0	18.7	1.18	1.20	1.03	3.41
No. 11.....	18.5	17.0	16.5	21.0	18.2	1.00	1.20	1.19	3.39
No. 12.....	20.5	16.0	16.5	21.0	17.8	.88	1.10	1.13	3.11
No. 13.....	22.5	16.0	16.5	20.0	17.5	.94	1.30	1.10	3.34
No. 14.....	25.0	16.0	16.5	20.0	17.5	1.46	1.10	1.38	3.94
<i>Test started in 1914:</i>									
No. 1.....	2.5	24.0	23.0	26.0	24.3	1.26	1.30	1.52	4.08
No. 2.....	3.0	24.0	23.0	26.0	24.3	1.60	1.70	1.64	4.94
No. 3.....	4.5	24.0	23.0	27.0	24.7	1.60	1.90	1.68	5.18
No. 4.....	6.0	24.0	23.0	28.0	25.0	2.10	1.80	1.83	5.73
No. 5.....	8.0	25.0	24.0	29.0	26.0	1.80	2.00	2.40	6.20
No. 6.....	10.0	25.0	24.0	30.0	26.3	2.24	2.30	1.90	6.44
No. 7.....	11.5	26.0	24.0	30.0	26.7	2.36	2.12	1.90	6.38
No. 8.....	13.0	26.5	23.5	30.0	26.7	2.20	1.98	1.86	6.04
No. 9.....	15.0	26.5	23.5	29.0	26.3	2.10	1.70	2.04	5.84
No. 10.....	16.5	26.0	23.0	29.0	26.0	2.10	1.80	2.13	6.03
No. 11.....	18.5	26.0	22.5	28.0	25.5	2.10	1.60	2.26	5.96
No. 12.....	20.5	26.0	21.0	28.0	25.0	2.40	1.70	2.00	6.10
No. 13.....	22.5	26.0	20.5	28.0	24.8	1.90	1.70	2.20	5.80
No. 14.....	25.0	26.5	20.5	28.0	25.0	2.10	1.70	1.76	5.56

It appears from these results that there is no need of more than 10 pounds of good seed per acre, and that under favorable conditions of soil and season somewhat less than 10 pounds of seed per acre is a safe rate to use.

Late summer seeding.—The late summer seeding of alfalfa in 1914 produced very good results in 1915. There was no winterkilling on any of the three seedlings made in August, 1914.

In the August 1 seeding, in winter-wheat stubble, the first cutting in 1915 yielded 1.66 tons per acre and the second cutting 1.79 tons per acre. The third cutting was pastured with sheep. The August 10 seeding, in oat stubble, yielded in three cuttings 3.94 tons per acre, and the August 20 seeding, also in oat stubble, yielded 3 tons per acre. These yields are practically equal to those secured from 2 and 3 year old alfalfa plats in the irrigated rotations.

Where late summer seeding of alfalfa is practiced it is preferable to plant on winter-grain stubble, as the grain can be removed from the field by the first part of August and the alfalfa seeded at once. The volunteer winter grain increases the yield of the first cutting the following year. For late summer seeding it is best not to disk or plow the ground, but to drill the seed into the stubble and irrigate the land immediately after planting. A good stand can be secured by this

method with more certainty than by seeding in the spring either with or without a nurse crop, to judge from the results so far secured at the experiment farm.

FALL IRRIGATION.

The fall irrigation of alfalfa was continued in 1915. As in previous years, fall irrigation produced no differences in yield, although the fall-irrigated alfalfa made a better growth in early spring than that which was not fall irrigated.

FALL IRRIGATION FOR ANNUAL CROPS.

Experiments in fall irrigation with oats, beets, flax, potatoes, barley, corn, and wheat were commenced in the autumn of 1913 and continued in 1914 and 1915. These seven spring-planted crops are grown in duplicate tenth-acre plats. The land is fall plowed, and one-half the plats are irrigated in November each year. The average yields secured in this experiment in 1914 and 1915 are shown in Table XI.

TABLE XI.—*Results in fall irrigation for annual crops at the Belle Fourche Experiment Farm in 1914 and 1915.*

Crop.	Average yield per acre, 1914.		Difference due to fall irrigation.	Average yield per acre, 1915.		Difference due to fall irrigation.
	Fall irri- gated.	Not fall irrigated.		Fall irri- gated.	Not fall irrigated.	
Corn.....bushels..	49.6	49.3	+ .3	28.67	31.54	— 2.87
Beets.....tons..	8.1	8.3	— .2	4.35	5.83	— 1.48
Potatoes.....bushels..	149.1	165.8	-16.7	92.40	102.40	-10.00
Wheat.....do..	30.0	21.9	+ 8.1	21.70	23.60	-1.90
Oats.....do..	43.4	43.9	— .5	65.80	80.20	-14.40
Barley.....do..	27.9	27.3	+ .6	35.30	38.40	-3.10
Flax.....do..	13.7	16.1	— 2.4	17.60	17.70	— .10

In 1914 the only crop that showed any increase in favor of fall irrigation was wheat. In 1915 all crops showed a slight decrease in yield where the land had been fall irrigated. In these experiments there has been no evidence that fall irrigation is advisable on these heavy gumbo soils if the soil contains a fair degree of moisture in the autumn, as was the case in both 1913 and 1914.

GRAIN VARIETY TESTS.¹

WINTER WHEAT AND RYE.

The yields of winter grain in 1915 were very satisfactory. The grains were sown on fallowed land under very favorable conditions. Irrigation was not necessary, on account of the heavy rainfall. All varieties except the Beloglina wheat and North Dakota No. 959 rye were sown on triplicate fiftieth-acre plats. The wheat was seeded at

¹ These tests are under the supervision of Mr. J. H. Martin, of the Office of Cereal Investigations, who prepared the report here made and whose work at the Belle Fourche Experiment Farm relates chiefly to the production of cereals without irrigation.

the rate of 4 pecks and the rye at the rate of $4\frac{1}{2}$ pecks per acre. The yields are shown in Table XII.

TABLE XII.—*Yields of winter wheat and rye at the Belle Fourche Experiment Farm in 1915.*

Group and variety.	C. I. No. ^a	Yield per acre.		Days to mature.
		Grain.	Straw.	
Crimean:				
Turkey.....	3055-159	66.6	5,330	324
Kharkof.....	1583	66.3	5,700	323
Do.....	4207	61.3	5,415	323
Beloglina.....	1667	b 52.1	4,875	321
Ghirka Winter:				
Ghirka (?).....	1437-397	59.1	5,280	326
Do.....	1442-343	57.5	5,250	324
Do.....	1437-394	51.9	4,915	325
Rye:				
Swedish rye (Minn. No. 2).....	137	44.6	4,165	321
Rye (N. Dak. No. 959).....		b 38.8	5,175	320

^a Cereal Investigations number.

^b One plat only.

The Turkey selected produced the highest average yield and was followed by the Kharkof, C. I. No. 1583. The awnless strains yielded somewhat less than the common bearded varieties.

SPRING WHEAT.

The spring-wheat varieties were seeded on disked corn ground at a rather late date. The yields were, as a result, much less than those of the winter wheats. The spring wheat received two irrigations. The plats were one-fiftieth of an acre each, and all varieties were sown in triplicate. A severe hailstorm shattered the wheat considerably while in shock, the loss being estimated at 10 per cent. The rate of seeding was 5 pecks per acre. The yields are shown in Table XIII.

TABLE XIII.—*Yields of spring wheat at the Belle Fourche Experiment Farm in 1915.*

Variety.	C. I. No.	Yield per acre.		Days to mature.
		Grain.	Straw.	
Kubanka (durum).....	1440	22.0	1,880	113
Marquis.....	3276	18.0	1,730	107
Power Fife.....	3025	14.7	1,775	111
Red Fife.....		12.1	1,740	113
Pringle Champlain.....	4782	12.2	1,455	108
Haynes Bluestem.....	2874	11.5	2,025	114
Defiance.....	3703	8.0	1,625	113

The highest yielding variety of spring wheat was the Kubanka, a durum wheat. Of the common wheats, Marquis led in both yield and quality. Defiance has been poor in yield for three years, and, as it is a soft wheat of poor milling quality, it can not be recommended.

OATS.

The oat varieties were grown on disked corn ground adjoining the spring wheat. All varieties except the Sixty-Day were irrigated twice. The yields were rather low, on account of late seeding and also because of the hail, which reduced them about 10 per cent. Seven varieties of oats were all sown in triplicate on fiftieth-acre plats. The rate of seeding was 10 pecks per acre. The yields are shown in Table XIV.

TABLE XIV.—*Yields of oat varieties at the Belle Fourche Experiment Farm in 1915.*

Variety.	C. I. No.	Yield per acre.		Days to mature.
		Grain.	Straw.	
Sixty-Day.....	165	34.0	840	93
Swedish Select.....	134	46.5	1,765	107
Canadian.....	444	44.7	1,825	106
Lincoln.....	781	50.7	1,640	107
Silvermine.....	782	52.3	1,675	105
Pete Edwards ¹	778	51.8	1,675	108
White Russian.....	551	52.8	2,305	116

¹ Obtained from a farmer named Edwards living in the vicinity of the farm; similar to Swedish Select.

Under irrigation the later varieties of oats have a decided advantage, because they are enabled to utilize a longer growing season without suffering from lack of water. Sixty-Day, the earliest variety grown, has always yielded rather low, while the White Russian, a very late side oat, has given the highest yields.

BARLEY AND EMMER.

Six varieties of barley and one variety of spring emmer were grown in 1915. They received but one irrigation. All varieties were grown on fiftieth-acre plats sown in triplicate. The common barleys were seeded at the rate of 6 pecks per acre and the hull-less varieties at 5 pecks per acre. They were sown on disked corn ground adjoining the oat varieties. The yields are shown in Table XV.

TABLE XV.—*Yields of barley varieties and emmer at the Belle Fourche Experiment Farm in 1915.*

Variety.	C. I. No.	Yield per acre.		Days to mature.
		Grain.	Straw.	
Two rowed:				
Chevalier II.....	530	39.2	1,650	105
Beresford Chevalier.....	1142	37.2	1,715	106
Six rowed:				
Coast (California Feed).....	690	23.0	1,005	97
Manchuria (Wis. No. 13).....	905	20.9	915	95
Hull-less:				
Nepal (White Hull-less, hooded).....	595	20.4	915	95
Guy Mayle (awned).....	.....	23.4	915	90
Emmer:				
White Spring emmer	1524	a 58.0	1,540	106

a 32 pounds per bushel.

The 2-rowed varieties have clearly outyielded the 6-rowed varieties, not only in 1915 but for the past three years as well. It will be seen that the 2-rowed Chevalier barleys matured several days later than the others. This probably accounts for the higher yield under irrigation, as the later varieties can utilize a longer growing period. The yields of hull-less barleys in pounds of grain per acre have equaled those of the 6-rowed hulled varieties.

Spring emmer yielded 58 bushels, computed at 32 pounds per bushel, or a total of 1,856 pounds of grain per acre, as compared to 1,871 pounds of the best variety of barley, Chevalier II. Considering the lower feeding value of the emmer, the growing of this crop is not recommended.

FLAX.

Six varieties of flax were grown in the varietal test in 1915. About two-thirds of the plats were on disked corn ground and the remainder on disked potato ground. There were three fiftieth-acre plats of each variety except the Smyrna, C. I. No. 30, of which there were two plats, both located on the corn ground. The plats that were on the ground which had produced potatoes the preceding season yielded from 50 to 80 per cent more than the same varieties on the corn ground adjoining. C. I. Nos. 8, 13, and 19 were shattered by hail to the extent of 5 or 10 per cent of the seed before thrashing, but the remaining varieties were thrashed before the hailstorm.

The flax was irrigated but once. The rate of seeding was 30 pounds per acre. The yields are shown in Table XVI.

TABLE XVI.—*Yields of flax varieties at the Belle Fourche Experiment Farm in 1915.*

Variety.	C. I. No.	Yield per acre.		Days to mature.
		Seed.	Straw.	
Smyrna.....	30	Bushels. ^a 6.0	Pounds. 1,260	105
Select Russian (N. Dak. No. 1215).....	3	14.5	1,725	105
N. D. R. (N. Dak. wilt resistant, No. 52).....	8	^b 13.6	1,475	103
Primost (Minn. No. 25).....	12	12.9	1,450	102
N. D. R. (N. Dak. wilt resistant) No. 114.....	13	^b 12.4	1,305	102
Russian (N. Dak. No. 155).....	19	^b 14.1	1,525	106

^a Two plats only.

^b Damaged by hail.

The Russian varieties, C. I. Nos. 3 and 19, gave the highest yields of seed. When hail damage is considered, the latter variety is probably the highest yielder. The low average yield of the Smyrna was due partly to the fact that all of it was grown on corn ground. However, this variety yielded much less than adjoining plats of Russian

flax and is undoubtedly the poorest seed-producing variety in the test. This variety was so short that it was almost impossible to cut it with the binder.

VARIETY TEST OF POTATOES.

In 1914 nine varieties of potatoes were tested, and in 1915 the number was increased to 20. The varieties were planted each year in duplicate rows 132 feet long. The yields secured in 1914 and 1915 are shown in Table XVII.

TABLE XVII.—*Yields of potatoes in a variety test at the Belle Fourche Experiment Farm in 1914 and 1915.*

Variety.	1915		1914		Two-year average yield per acre.
	Yield per acre.	Marketable.	Yield per acre.	Marketable.	
Extra Early Ohio.....	79.6	78.4			
White Ohio.....	73.8	84.4			
Carman No. 3.....	146.5	84.7			
Red River Acme.....	72.1	80.5			
Irish Cobbler.....	78.8	76.9			
Peerless.....	154.9	87.6			
Early Ohio.....	62.3	77.4	65.2	92.0	63.7
Albino.....	72.4	78.3	100.5	83.6	86.4
Peachblow.....	90.8	75.1	124.5	76.0	107.6
Burbank.....	120.8	91.9			
Russet.....	126.1	86.0	97.7	80.0	116.9
Professor Maerker.....	162.9	93.6	149.2	89.0	156.0
Early Silver Skin ¹					
Delaware ¹					
Pinkeye ¹	46.5	77.5	104.2	78.0	75.3
Norcross ¹					
Keeper ¹	112.9	70.1	105.0	58.0	108.9
Pearl.....	62.7	87.5	116.2	79.0	89.4
Triumph.....	63.9	78.7	76.5	81.4	70.2
Rural New Yorker ¹	120.8	91.9			
Olds Prolific ¹	177.8	92.0			
Sir Walter Raleigh ¹	135.0	91.1			
Green Mountain ¹	131.0	90.3			

¹ Single rows only.

In both years the late varieties produced decidedly better yields than the early ones and also a much higher percentage of marketable tubers. The most promising variety as to yields, percentage of marketable tubers, and cooking qualities so far tested is selection No. 4452.

VARIETY TEST OF CORN.¹

In 1915, 10 varieties of corn were tested on irrigated land. The yields obtained are shown in Table XVIII, in which dry-air weights of grain are given. The varieties were grown in triplicate plats, two rows wide, and 132 feet long.

¹ Made in cooperation with the Office of Corn Investigations.

TABLE XVIII.—*Average yields of corn in variety tests at the Belle Fourche Experiment Farm in 1913, 1914, and 1915.*

Variety.	1913		1914		1915		Three-year average yield per acre.
	Date of maturity.	Yield per acre.	Date of maturity.	Yield per acre.	Date of maturity.	Yield per acre.	
Martens White Dent	Sept. 11	<i>Bushels.</i> 60.4	Sept. 22	<i>Bushels.</i> 45.4		<i>Bushels.</i> 23.7	<i>Bushels.</i> 43.1
Lyman White Cap.....			Sept. 15	41.1			
U. S. Selection No. 133.....	Sept. 13	56.2	Sept. 28	39.0		20.4	38.6
Payne White Dent.....	Sept. 11	55.3	Sept. 25	37.4		22.2	38.6
Disco Dent.....	Sept. 15	45.5	Sept. 28	35.9			40.7
Brown County Yellow Dent	Sept. 6	51.2	Sept. 20	34.7			42.9
Ardmore Dent.....	do.....	49.2	do.....	34.4			41.8
Northwestern Dent.....	Sept. 4	56.2	Sept. 15	31.5	Sept. 23	34.1	30.6
Navajo.....						19.9	
Disco Ninety-Day.....						22.7	
Disco Pride.....						23.3	
White Australian.....						22.4	
Disco Eighty-Five Day.....						23.5	
Gehu Flint.....					Sept. 18	28.7	

The only varieties that matured in 1915 were the Northwestern Dent and the Gehu Flint. In the 3-year average Martens White Dent shows the highest yields, with Northwestern Dent second. For this locality the Northwestern Dent is one of the safest varieties to plant. In 1915 all other varieties except Gehu Flint were practically failures, as none of them matured properly.

SPACING TEST FOR CORN.

In order to study the effect of spacing corn at various distances under irrigation, the following spacing distances in the row were tried in 1915: 7, 10, 14, 17, 21, and 30 inches. The rows were 42 inches apart. The test was conducted in triplicate plats. The average yields for 1914 and 1915 are given in Table XIX.

TABLE XIX.—*Average yields of corn planted at different distances within the row at the Belle Fourche Experiment Farm in 1914 and 1915.*

Distance within the row.	Average yield per acre, 1914.		Ratio of grain to stover, 1914.	Average grain yield per acre, 1915.	Two-year average yields of grain, per acre.
	Grain.	Stover.			
	<i>Bushels.</i>	<i>Tons.</i>			<i>Bushels.</i>
7 inches.....	36.00	1.53	1 : 1.10	24.3	30.1
10 inches.....	39.36	1.16	1 : .84	27.9	33.6
14 inches.....	41.33	1.23	1 : .83	27.8	34.5
17 inches.....	40.63	1.13	1 : .78	24.9	31.8
21 inches.....	38.30	1.06	1 : .78	23.2	30.5
30 inches.....				20.0	

The yields of stover in 1915 could not be determined, owing to damage by hail. There was comparatively little difference in the yield of grain. In the thicker plantings the corn was inferior in quality and would be difficult to husk on account of the great number of small ears. The most desirable distances seem to be 10, 14, and 17

inches. A closer planting than 10 inches reduces the quality of the corn and a lighter planting than 17 inches is likely to reduce the yield. Where the land is weedy it is a more desirable practice to check the corn on irrigated land, and a stand of three stalks per hill appears to be the most desirable. To insure a perfect stand, the ground should be thoroughly prepared by good plowing, double disking, and harrowing.

TIME OF BREAKING DRY-LAND SOD.

An experiment was started in 1911 to determine the effect of breaking sod land at different times of the year: A series of 0.24-acre plats was plowed, one plat each month, from April to October, inclusive, from 1911 to 1914. The plat plowed first in the spring each year was replowed in the fall, and one plat was seeded each year immediately after breaking. The breaking was kept free from weeds by disk ing, and all plats were plowed in the fall each year after being cropped. Owing to extreme droughts, out of the four crops planted only two were harvested. These were harvested in 1913 and 1915. Table XX gives the results obtained in 1913 and 1915.

TABLE XX.—*Yields of Sixty-Day oats in the time-of-breaking experiment at the Belle Fourche Experiment Farm.*

RESULTS OBTAINED IN 1913.

Plat No.	Time of breaking.	Yield per acre.		Plat No.	Time of breaking.	Yield per acre.	
		Grain.	Straw.			Bushels.	Pounds.
1911.							
1.....	Apr. 1	10.1	.448	9.....	Apr. 1	5.9	.360
2.....	May 1	6.9	.344	10.....	May 1	6.0	.336
3.....	June 1	5.3	.236	11.....	June 1	6.1	.304
4.....	July 1	3.8	.204	12.....	July 1	4.8	.240
5.....	Aug. 1	7.6	.260	13.....	Aug. 1	3.9	.116
6.....	Sept. 1	5.5	.192	14.....	Sept. 1	4.3	.176
7.....	Oct. 1	5.2	.208	15.....	Oct. 1	3.8	.144
1912.							
8.....	Apr. 1	(1)	(1)	16.....	Apr. 15	.9	.28

RESULTS OBTAINED IN 1915.

Plat No.	Date of breaking and treatment previous to first planting.	Yield per acre.		Plat No.	Date of breaking and treatment previous to first planting.	Yield per acre.		
		Grain.	Straw.			Bushels.	Tons.	
1911.								
1.....	April, backset.....	59.8	.72	17.....	May, backset.....	52.0	.58	
2.....	May.....	50.1	.65	18.....	June.....	59.5	.68	
3.....	June.....	55.7	.61	19.....	July.....	53.4	.59	
4.....	July.....	54.9	.65	20.....	August.....	61.9	.69	
5.....	August.....	49.8	.61	21.....	September.....	61.3	.71	
6.....	September.....	49.9	.61	22.....	October.....	56.4	.70	
7.....	October.....	50.6	.64	1914.				
1912.								
8.....	April.....	55.8	.64	23.....	April.....	68.9	.87	
9.....	May, backset.....	56.8	.60	24.....	May, backset.....	86.0	1.11	
10.....	May.....	56.9	.62	25.....	May.....	86.3	1.06	
11.....	June.....	51.0	.63	26.....	June.....	83.3	.98	
12.....	July.....	56.0	.67	27.....	July.....	63.5	.71	
13.....	August.....	45.3	.48	28.....	August.....	57.5	.70	
14.....	September.....	48.5	.51	29.....	September.....	60.4	.78	
15.....	October.....	54.0	.69	30.....	October.....	56.2	.49	
16.....	April.....	53.6	.67	31.....	April.....	47.7	.55	

¹ The records of this plat were lost.

The early breaking, from April to July, has been the best for the first crop following. The replowing of the early breaking gave no increased yields. After the first year, there has been no consistent effect on the yield resulting from the time of breaking.

TREES AND SHRUBS.

All the trees and shrubs on the experiment farm came through the winter of 1914-15 without any winterkilling. This is the first winter that pines came through without any setback. This was probably due to the fact that they were sheltered to some extent by the other trees and also covered with snow from early December to March.



FIG. 5.—View in the irrigated forestry planting at the Belle Fourche Experiment Farm in 1915. Russian oleaster is shown at the left, white elm in the center, and white willow at the right.

On November 28, 1914, the trees were given a thorough irrigation. The only instance where the irrigation had a bad effect was on trees that were heavily mulched, as the ground was still frozen solid around these trees as late as the latter part of May, 1915. Summer irrigation should be done early, before August 1, so as to allow the trees time to ripen before frost. Late fall irrigation seems desirable for trees, as they come through the winter in better condition in wet soil than in dry soil. A view of a part of the irrigated forestry planting is shown in figure 5.

The only new variety added to those already reported was Chinese arbor vitae. A good stand was secured and for the first season made a very good growth. This seems to be one of the most promising of the evergreens.

For a quick-growing windbreak, Carolina and Norway poplars are probably the best. These should be planted in alternate rows with green ash, white elm, and honey locust and on each side finished with Russian oleaster and Siberian pea tree. The trees while small will do better in close planting and will also shade the ground and help keep out the weeds. A convenient distance is rows 8 feet apart with the trees 4 feet apart in the row. This will allow for cross cultivation the first year or two with a 1-horse cultivator and will give room enough between the rows to use a spring-tooth harrow. The trees must be kept free from weeds at all times.

For ornamental planting, buckthorn, high-bush cranberry, common snowball, Siberian dogwood, hydrangea, common barberry, purple barberry, Japanese barberry, *Spirea van houttei*, *Spirea opulifolia*, yellow currant, golden elder, common elder, and lilac have all done well and seem to be suitable for local conditions and climate.

Approved:

Wm. A. TAYLOR,

Chief of Bureau.

MAY 3, 1916.

